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54 Hearing-aid, in particular behind-the ear hearing aid.

57 The hearing aid, in particular a behind-the-ear hearing aid (1, 2) comprises:

a first unit (1) comprising an amplifier (4), a part-the hook (3) - formed with a duct (16) and a space (8),

a second unit (2) comprising an electro-acoustic transducer (12), which second unit is intended to be worn in the ear,

A tubular element (15) for the mechanical connection of the two units (1, and 2, respectively), which tubular element accommodates connecting means (14) for electrically coupling the transducer (12) to (an output of) the amplifier (4).

The duct (16) has such a diameter that, if the element (15) has not been secured inside the hook (3), the element (15) is axially slidable inside the duct (16). This enables the hearing aid to be adapted to the size of the ear of the person wearing the hearing aid. The connecting means (14) have such a length that even in the case of adaptation of the hearing aid to a big ear the electrical connection is still in tact or can be made. When the hearing aid is adapted to a smaller ear, the connecting means (14) are in fact too long. The space (8) is intended for taking up the excess length of the connecting means (14).

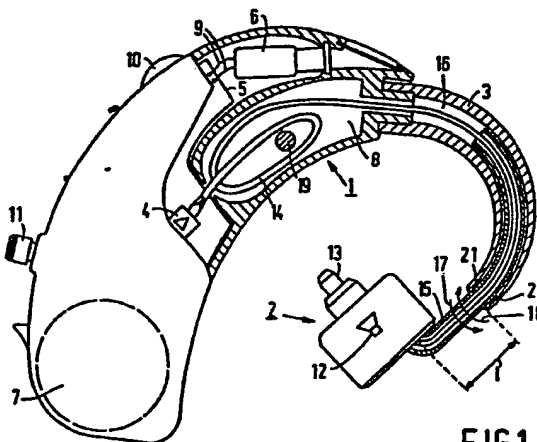



FIG.1

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84 Hearing-aid, in particular behind-the ear hearing aid.

87 The hearing aid, in particular a behind-the-ear hearing aid (1, 2) comprises:

a first unit (1) comprising an amplifier (4), a part-the hook (3) - formed with a duct (18) and a space (8),  
a second unit (2) comprising an electro-acoustic transducer (12), which second unit is intended to be worn in the ear.

A tubular element (15) for the mechanical connection of the two units (1, and 2, respectively), which tubular element accommodates connecting means (14) for electrically coupling the transducer (12) to (an output of) the amplifier (4).

The duct (16) has such a diameter that, if the element (15) has not been secured inside the hook (3), the element (15) is axially slidable inside the duct (16). This enables the hearing aid to be adapted to the size of the ear of the person wearing the hearing aid. The connecting means (14) have such a length that even in the case of adaptation of the hearing aid to a big ear the electrical connection is still in tact or can be made. When the hearing aid is adapted to a smaller ear, the connecting means (14) are in fact too long. The space (8) is intended for taking up the excess length of the connecting means (14).

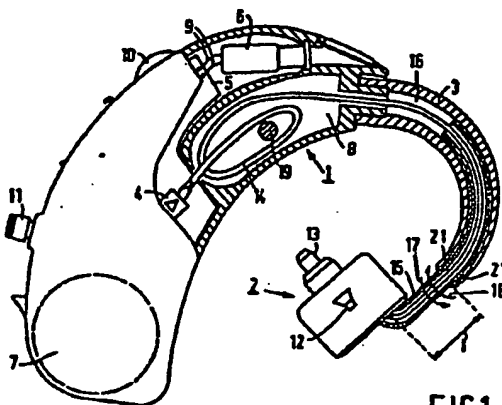


FIG.1

EP 0 158 391 A1

"Hearing-aid, in particular behind-the-ear hearing aid."

The invention relates to a hearing aid, in particular a behind-the-ear hearing aid, comprising;

- a first unit comprising an amplifier,
  - a second unit comprising an electro-acoustic transducer, which second unit is intended to be worn in the ear,
  - first connecting means enabling the electro-acoustic transducer to be coupled electrically to the amplifier, and
  - second connecting means enabling the two units to be inter-coupled mechanically, which second connecting means comprise a tubular element of which a first end is coupled to one unit, which element accommodates the first connecting means.
- Such a hearing aid is disclosed in British Patent Specification no. 792,742 and United States Patent Specification no. 4,291,203. British Patent Specification 792,742 describes a behind-the-ear hearing aid in which the first unit is intended to be worn behind the ear and which, in addition to the amplifier, comprises a microphone and a battery. The electro-acoustic transducer in the second unit is the loudspeaker (also referred to as earphone.) The first connecting means provide an electrical coupling between an output of the amplifier in the first unit and the loudspeaker in the second unit. United States Patent Specification 4,291,203 describes a hearing aid in which the first unit is intended either to be worn behind the ear or to be incorporated in a spectacles frame. In addition to the amplifier, the first unit comprises a loudspeaker and a battery. The electro-acoustic transducer in the second unit is the microphone. Thus, the first connecting means establish an electrical coupling between the microphone and an input of the amplifier.

It has been common practice to give the first and the second connecting means such a length and shape that they match the shape of the ear, so that they are less conspicuous, see for example the above-mentioned British Patent Specification no. 792,742.

This tailoring of the first and the second connecting means, which has to be done by the hearing-aid retailer or by an audiologist, is an intricate and time-consuming job in the case of the hearing aids described in the above-mentioned publications.

The invention aims at providing a hearing aid which enables this tailoring of the connecting means to be effected in a very simple manner. According to the invention the hearing aid is characterized in that a part of the other unit has a duct of a diameter larger than the outer diameter of the tubular element, so that in a condition in which the tubular element is not secured relative to said part of the other unit, said tubular element is slidable in said duct over at least a part of its length and in the longitudinal direction of said duct, and in a condition in which the tubular element is secured relative to said part of the other unit, said tubular element extends in the duct over at least a part of its length, the first connecting means have such a minimum length that, viewed from the other unit, when the tubular element in the duct of said part has been slid out of said duct to the maximum permissible extent, the electrical coupling is still intact or can be made, and at least one of the two units has a space for taking up the excess length of the first connecting means when the tubular element has been slid further into the duct in said part. The advantage of this construction is that the manufacturer of the hearing aid can supply the complete aid to the retailer or audiologist, even in such a way that the electrical coupling of the first connecting means to the amplifier and to the electro-acoustic transducer may have been made already. In fact, only the second connecting

means have to be adapted. For this purpose the tubular element is slidable in said part of the other unit. The retailer or audiologist can now vary the distance between the two units and hence adapt the second connecting means exactly to the shape of the ear (i.e. the length of the portion of said means which project from the duct viewed from said other part) by simply sliding the tubular element further into or out of the duct in said part of the other unit. Once the correct length has been found the tubular element may be secured in the duct, for example by means of an adhesive or by clamping, for example by means of a clamping nut. It is obvious that other means may be employed for securing the tubular element.

The phrase "when the tubular element has been slid out of said duct to the maximum permissible extent" is to be understood to mean either that position of the tubular element in the duct in which, viewed from the other unit, it has been slid out of the duct as far as possible while still allowing it to be secured in the duct, or that position of the tubular element in the duct in which the first connecting means do not allow the element to be slid out any further because otherwise the electrical coupling would not remain intact or could no longer be made.

Evidently, the length of the first connecting means should be such that even if the hearing aid (in particular the second connecting means) has to be adapted to a big ear, so that the length of the part of the second connecting means which projects from the duct must be large, the electrical coupling remains in tact or can still be made. In the case of adaptation to a smaller ear the length of the first connecting means will be too large. By sliding the tubular element further into the duct during adaptation this excess length is automatically slid into the relevant space. Thus, it is no longer necessary to cut a part to size. The correct length can be determined simply by sliding the tubular element into the duct, after which the tubular element may be secured, so that the hearing aid

can be adapted in a very simple and rapid manner.

Another advantage can be obtained in that, if the tubular element is made of a flexible material, the hearing aid can be adapted very simply and rapidly to the left ear or the right ear. Thus, if a possible ear piece containing the second unit, is disregarded, no specific parts for a specific ear are required. The hearing aid can always be adapted to a left or right ear by rotating the tubular element about its longitudinal axis before it is fixed in the duct.

A further advantage is that the tubular element may provide pull-relief. The second unit (which is to be worn in the ear) may be removed from the ear by pulling at the first unit. Via the second connecting means (the tubular element) the pulling force is transmitted to the second unit, so that it can be pulled out of the ear without a tensile force being exerted on the first connecting means (the electrical wiring). The tubular element thus provides stress-relief for the first connecting means.

It is to be noted that the adaptation of the length of the second connecting means to the ear has also been described in German Offenlegungsschrift no. 27.21.469. The method of adapting this length described therein differs completely from that described above. When the method described in said German Offenlegungsschrift is used the correct length is obtained by cutting a lead provided with two conductive foils and subsequently making both the mechanical and the electrical connections by means of a special clamping contact. Such a method is more intricate and expensive.

In a hearing aid in accordance with the invention the space for taking up the excess length of the first connecting means is preferably provided with a spindle around which the first connecting means have been wound at least once. This can ensure that during insertion of the tubular element into the duct the excess length of the

first connecting means can be taken up more readily in said space. Taking up the excess length can be facilitated even further by arranging a spiral spring on the spindle, securing one end of the spiral spring to a fixed part of the unit in which the space is formed, and securing the other end to the first connecting means. When the tubular element has been inserted into the duct to the maximum extent it can be arranged that the spiral spring is wound up fully.

Since the second unit is intended to be worn in the ear, this unit generally has a small volume. The first unit generally has a larger volume, which means that said space is preferably formed in the first unit. However, it can also be possible that both units are provided with a space, each space taking up a part of the excess length of the first connecting means.

A hearing aid in accordance with the invention in the form of a behind-the-ear hearing aid, in which the first unit is banana-shaped and is intended to be worn behind the ear, for which purpose it comprises a hook, may be further characterized in that the first unit is said other unit and that said part of the other unit is the hook of the behind-the-ear hearing aid. The said part (the hook) is also tubular and is curved in the longitudinal direction so as to be hooked over the connection between the ear lobe and the head.

In the foregoing it has been stated that a hearing aid manufacturer may deliver a hearing aid in accordance with the invention to an audiologist or a hearing-aid retailer in a condition in which the tubular element has not yet been secured in the duct but in which the electrical connection with the aid of the first connecting means has already been made. In such a case the audiologist or retailer cannot choose a different combination of a specific first and a specific second unit without severing the electrical connection. In order to give the audiologist or retailer the possibility of selecting a desired

combinati n f a sp cific first and a sp cific s cond unit, the manufactur r may supply s parate first and second units which contain the first connecting means but which have not yet been inter-connected electrically.

6 In practice the manufacturer then supplies a unit, preferably the first unit, which has a space for taking up the excess length of the first connecting means and a unit, preferably the second unit, to which one end of the tubular element and one end of the first connecting means have  
10 already been coupled, the first connecting means extending at least partly inside the tubular element. The desired first and second units may then be coupled electrically to each other by the audiologist or retailer, after which the hearing aid can be adapted in the manner described in  
15 the foregoing.

The invention will now be described in more detail, by way of example, with reference to the drawings, in which identical reference numerals in different Figures relate to identical elements. In the drawings:

20 Figs. 1 to 3 show a first embodiment and

Fig. 4 shows part of a second embodiment of the invention,

Fig. 5 shows a different attachment of the tubular element with the hook used in the embodiments shown in  
25 Figs. 1 to 4,

Fig. 6 shows another embodiment of the invention, and

Fig. 7 shows an example of the first connecting means.

30 Fig. 1 shows an embodiment of the invention in the form of a behind-the-ear hearing aid comprising a first unit 1 intended to be worn behind the ear and a second unit 2 intended to be worn in the ear. Fig. 1 is a side view and partly a sectional view of the first unit 1. The first  
35 unit 1 is banana-shaped and has a hook 3 with which unit 1 is hooked behind the ear. The unit 1 comprises an amplifier, represented schematically by the element bearing the



reference numeral 4, which amplifier is accommodated in a p.c. board 5 in unit 1, a microphone 6, a battery 7, and a space 8. By means of the electrical wires 9 the microphone 6 is electrically coupled to the p.c. board 5 and thus to an input of the amplifier 4 on the p.c. board 5. The first unit further comprises a volume control 10 and an on/off switch 11. The second unit 2, which is shown in elevation, comprises an electro-acoustic transducer in the form of a loudspeaker (or earphone). The earphone is shown only schematically, see the reference numeral 12. The part referenced 13 is the outlet aperture for the sound produced by the earphone 12. The unit 2 must be incorporated either in a special ear-piece (not shown) whose shape matches the shape of the earshell of the person wearing the hearing aid or in a standard earpiece.

The hearing aid further comprises first connecting means 14 enabling the output of the amplifier 4 to be coupled electrically to the earphone 12 and second connecting means 15 enabling the two units 1 and 2 to be intercoupled mechanically. The second connecting means 15, shown in sectional view, are constructed as a tubular element inside which the first connecting means 14 are arranged.

A part of the first unit 1, namely the hook 3, is formed with a duct 16 of a diameter which is larger than the outer diameter of the tubular element 15, in such a way that the tubular element, when it is not fixed relative to the hook 3, is slidable inside the duct 16 over at least a part of its length and in the longitudinal direction of said duct. Fig. 1 shows the hearing aid in which the tubular element 15 has been inserted into the duct 16 for the greater part. Fig. 2 shows the same hearing aid, but now the tubular element 15 projects from the element over approximately half its length. Fig. 3 also shows the same hearing aid but now the tubular element 15 has been slid out of the duct 16 over the greater part of its length.

This slidability of the tubular element 15 in the duct 16 is necessary in order to adapt the hearing aid, and in particular the length (see Fig. 1) between the end of the hook 3 and the second unit 2, or the effective length of the tubular element 15, to the size of the ear of the user of the hearing aid. The far inserted position of Fig. 1 is intended for adaptation to a small ear and the far extended position of Fig. 3 is intended for adaptation to a big ear. The hearing aid shown in Fig. 2 has been adapted to an ear of average size.

It will be appreciated that in the present case, in which the tubular element 15 must be slidable inside the curved hook 3, the tubular element 15 should be made of a flexible material. This also has the advantage that the hearing aid shown in Fig. 1 may be used both for a left ear and for a right ear. This adaptation can be obtained by rotating the tubular element 15 about its longitudinal axis as indicated by the arrows 17 and 18 in Fig. 1. By rotating the tubular element 15 (as indicated by the arrow 17) through  $90^\circ$  in such a way that the second unit 2 has moved forwards out of the plane of the drawing, a hearing aid for a left ear is obtained. By rotating the tubular element 15 (as indicated by the arrow 18) through  $90^\circ$  in such a way that the second unit 2 is rotated backwards out of the plane of the drawing, a hearing aid is obtained which can be worn behind the right-ear.

Obviously, the length of the first connecting means (the electrical wiring) 14 should be such that it is long enough to establish the electrical coupling between the amplifier 4 and the earphone 12, even when the hearing aid is adapted to a big ear (Fig. 3). This means that in the case of adaptation of the hearing aid to a smaller ear (Figs. 1 and 2) the first connecting means 14 will be too long. The above-mentioned space 8 has been formed in the unit 1 in order to take up the excess length of the first connecting means 14 if the tubular element 15 is in a position in which it has been slid further into

the duct 16. This is clearly visible in Figs. 1 and 2. By inserting the tubular element 15 further into the duct 16 the excess length of the electrical wiring 14 is slid into the space 8.

5 In order to facilitate this insertion of the wiring 14 into the space 8 the space is preferably provided with a spindle 19 around which the wiring 14 is wound at least once. Without this spindle the wiring 14 would be pulled taut, i.e. into a straight line, in the space 8  
10 when the tubular element 14 is pulled out of the duct 16 as far as possible. When the element is subsequently slid inwards this might give rise to problems because the electrical wiring 14 will not bend easily, which is necessary if the excess length is to be taken up in the  
15 space 8. By winding the wiring 14 at least once around the spindle 19 the wiring 14 will already have a curved portion even if the element 15 has been slid out as far as possible (Fig. 3), so that taking up the excess length is now much easier.

20 Taking up the excess length in the space 8 can be further improved (see Fig. 4) by arranging a spiral spring 25 on the spindle 19, one end of the spring being secured to the spindle or elsewhere to the housing in which the space 8 is formed, and the other end to the  
25 first connecting means. Fig. 4 shows the tubular element 15 in a far inserted position in the duct 16. The spiral spring 25 is then wound up (almost ) fully. By pulling the element 15 further outwards the spiral spring 25 is expanded so that it is further tensioned and exerts an  
30 inwardly directed force (into the space 8) on the electrical wiring 14, which further facilitates taking up the wiring 14 when the element 15 is again slid into the duct 16.

35 Another step which may be applied to the hearing aid shown in Fig. 1, with or without spindle 19, is to lead the wiring 14 from the connection to the p.c. board 5 to that side of the space where the duct 16 terminates

into the said space and to connect the wiring at this location to a fixed position in the said space. In this way a similar loop is formed in the wiring as shown in Fig. 1.

After the hearing aid has been adapted (by shifting the element 15 inside the duct 16), the element 15 must be secured in the hook 3. In Figs. 1 to 3 this is effected by means of an adhesive 21.

Fig. 5 illustrates a different method of securing the tubular element 15 in the hook 3. Fig. 5 shows only a part of the two elements. Moreover, the wiring 14 is not shown for the sake of clarity. The construction comprises a clamping nut 30 with internal screwthread. The end portion of the hook 3 is formed with a slit 31. Thus, when the nut 30 is tightened the hook 3 is compressed, thereby clamping the tubular element 15 inside the duct 16.

It will be appreciated that yet other methods of securing are also possible.

Another embodiment of the invention is shown in Fig. 6. The difference with respect to the embodiment shown in Figs. 1 to 3 resides in that part of the first unit 1' which contains the duct 16'. This duct 16' is short and simply comprises a hole in the housing of the first unit 1'. The tubular element 15' is longer and now terminates in the space 8. Fig. 6 shows a hearing aid in which the tubular element 15' has been slid out to the maximum extent. In the case of adaptation to a smaller ear, the tubular element 15' should be slid further into the duct 16', i.e. further into the space 8. The tubular element 15' is again secured inside the duct 16' by means of an adhesive 21.

Fig. 7 shows an example of the first connecting means 14 which may be used in the hearing aid in accordance with the invention. The connecting means 14 may be

constructed as a core 40, of, for example, a plastic material (nylon) around which the electrical conductors 42 and 43 have been wound. This assembly is accommodated

in a sleeve 41. Only the sleeve 41 is shown in cross-section. The core 40 and the conductors 42 and 43 are shown in side view. Depending on the type of electro-acoustic transducer in the second unit 2 three conductors may be arranged around the core. If the second unit 2 accommodates both the microphone and the earphone, even four or five conductors may be wound around the core 40.

These first connecting means have the advantage that they are inherently stress-relieved, namely by means of the core 40. The ends of the core are then mechanically secured in the first and the second unit. If the user of the hearing aid now grips the tubular element 15 or 15' with the fingers in order to pull the second unit 2 out of the ear, the first connecting means 14 will be clamped in the element 15 or 15' by compressing this element. Since the conductors 42, 43 have been wound around the core no tensile force will be exerted on the conductors 42, 43, but only on the core 40.

It is to be noted that the invention is not limited to the embodiments shown in the Figures. Various modifications to the embodiments described are possible without departing from the scope of the invention as defined in the Claims. For example:

- a) the space for taking up the excess length of the first connecting means may be formed in the second unit,
- b) the second unit may contain the microphone (in which case the first connecting means establish an electrical connection between the microphone and the input of the amplifier,
- c) the second unit may accommodate both the loudspeaker and the microphone (in which case the first connecting means establish two electrical connections, namely between the amplifier and the loudspeaker and between the amplifier and the microphone),
- d) the hearing aid is constructed as a pair of hearing spectacles and the first unit is accommodated in the spectacle frame.

A hearing-aid manufacturer may supply a hearing aid in accordance with the invention either in the fully assembled condition or in such condition that only the tubular element 15 or 15' has not yet been secured in the duct 16 or 16' (the electrical connection 14 has been made already), or as two separate parts, one part comprising a first unit 1 or 1' and the other part comprising the second unit 2, to which one end of the tubular element 15 or 15' and the first connecting means 14 have already been secured.

In the last-mentioned case the retailer or audiologist has the freedom to combine a first unit of a specific type and a second unit of a specific type. The other end of the first connecting means 14 must then be fed through the duct 16 or 16' and secured to terminals on the p.c. board 5. Subsequently, the hearing aid can be adapted by shifting the tubular element 15 or 15' in the duct 16 or 16' and then securing the tubular element 15 or 15'.

In the last but one case the retailer or audiologist does not have such a combination possibility and can only adapt the hearing aid by shifting and subsequently securing the tubular element 15 or 15' in the duct 16 or 16'.

25

1. A hearing aid, in particular a behind-the-ear hearing aid, comprising :

- a first unit comprising an amplifier,
- a second unit comprising an electro-acoustic transducer which second unit is intended to be worn in the ear;
- first connecting means enabling the electro-acoustic transducer to be coupled electrically to the amplifier, and

- second connecting means enabling the two units to be inter-coupled mechanically, which second connecting means comprise a tubular element of which a first end is coupled to one unit, which element accommodates the first connecting means,

characterized in that a part of the other unit has a duct of a diameter larger than the outer diameter of the tubular element, so that in a condition in which the tubular element is not secured relative to said part of the other unit, said tubular element is slidable in said duct over at least a part of its length and in the longitudinal direction of said duct and in a condition in which the tubular element is secured relative to said part of the other unit said tubular element extends in the duct over at least a part of its length, the first connecting means have such a minimum length that, viewed from the other unit, when the tubular element in the duct of said part has been slid out of said duct to the maximum permissible extent, the electrical coupling is still intact or can be made and at least one of the two units has a space for taking up the excess length of the first connecting means when the tubular element has been slid further into the duct in said part.

2. A hearing-aid as claimed in Claim 1, characterized in that the tubular element is made of a flexible

material.

3. A hearing aid as claimed in Claim 1 or 2, characterized in that said part of the other unit is also tubular.

6 4. A hearing aid as claimed in Claim 1, 2 or 3, characterized in that the space is provided with a spindle around which the first connecting means have been wound at least once.

10 5. A hearing aid as claimed in Claim 4, characterized in that a spiral spring is arranged on said spindle, one end of the spiral spring is secured to a fixed part of the unit in which the space is formed and the other end is secured to the first connecting means.

15 6. A hearing aid as claimed in any one of the preceding Claims, characterized in that said space is formed in the first unit.

20 7. A hearing aid as claimed in any one of the preceding Claims, characterized in that the tubular element is secured relative to said part of the other unit by means of an adhesive.

8. A hearing aid as claimed in any one of the Claims 1 to 6, characterized in that said tubular element is secured relative to said part by clamping, for example, by means of a clamping nut.

25 9. A hearing aid as claimed in any one of the preceding Claims, in the form of a behind-the-ear hearing aid, in which the first unit is banana-shaped and is intended to be worn behind the ear, for which purpose it comprises a hook, characterized in that the first unit is said other unit and said part of the other unit is the hook of the behind-the-ear hearing aid.

30 10. A unit, preferably the first unit, for use in a hearing aid as claimed in any one of the preceding Claims, characterized in that the unit has a space for taking up the excess length of the first connecting means.

11. A unit, preferably the second unit, for use in a hearing-aid as claimed in any one of the Claims 1 to 9,



characterized in that on one end of the tubular element and on the other end of the first connecting means are coupled to the unit, and the first connecting means extend inside the tubular element over at least a part of their length.

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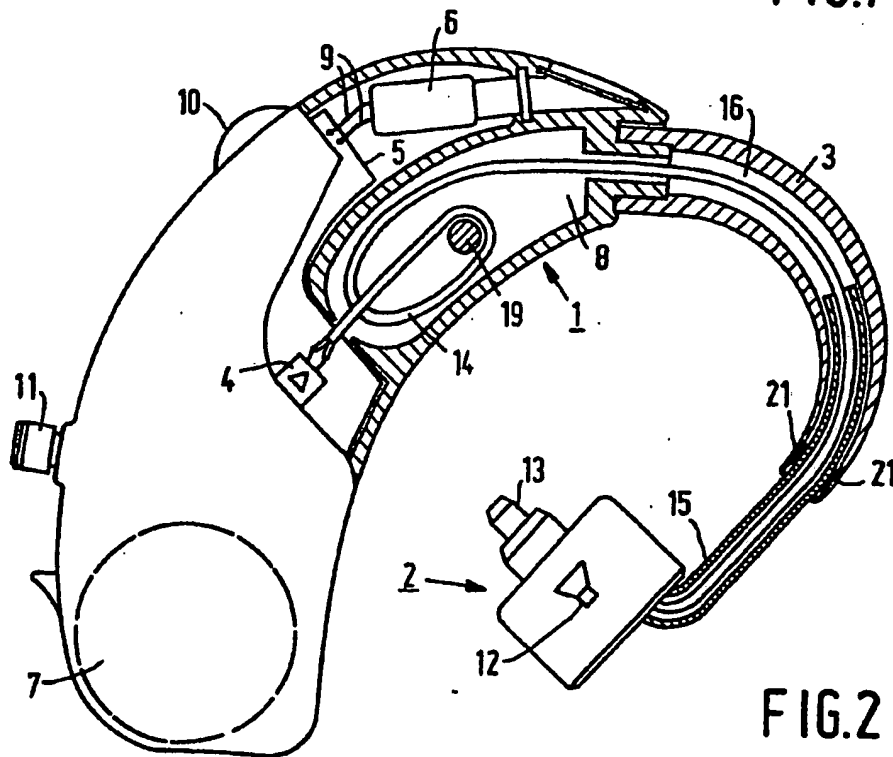
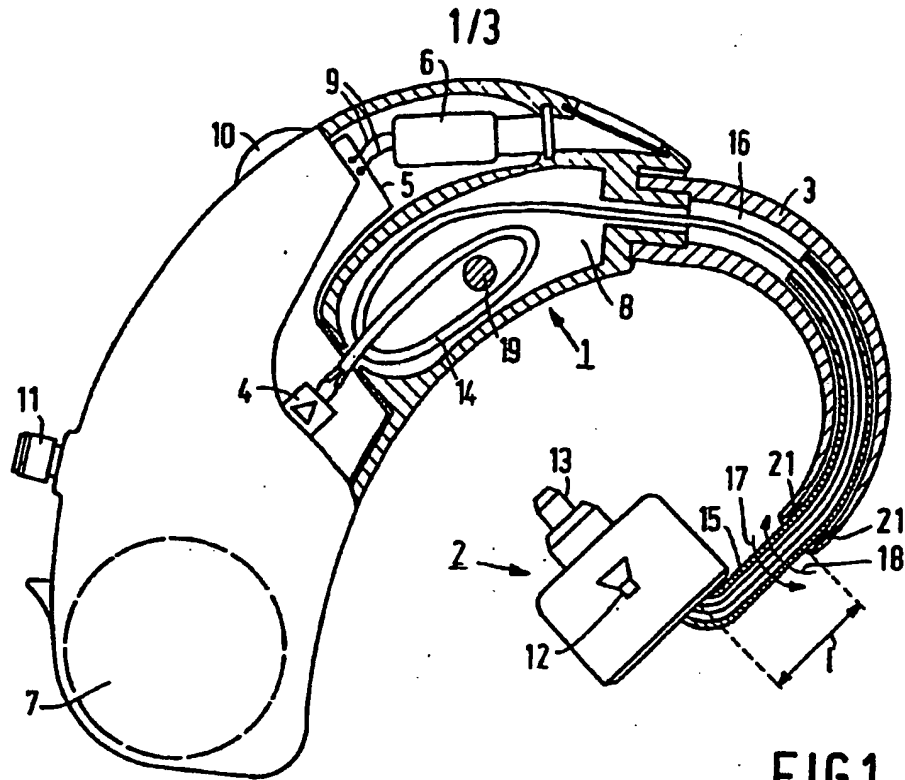
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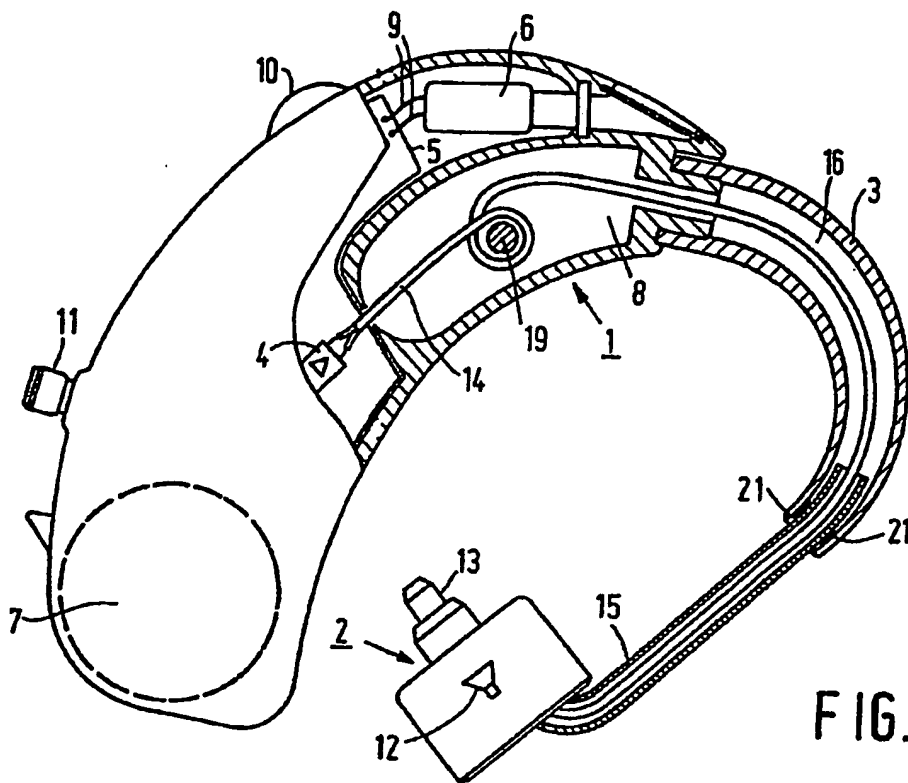


FIG. 3

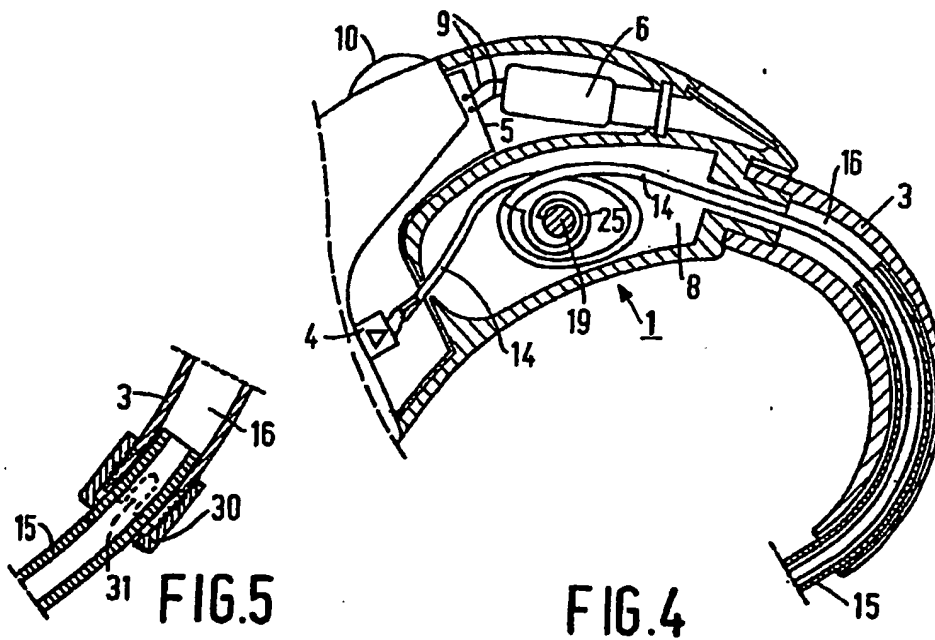


FIG. 4

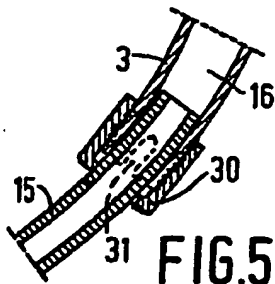


FIG. 5

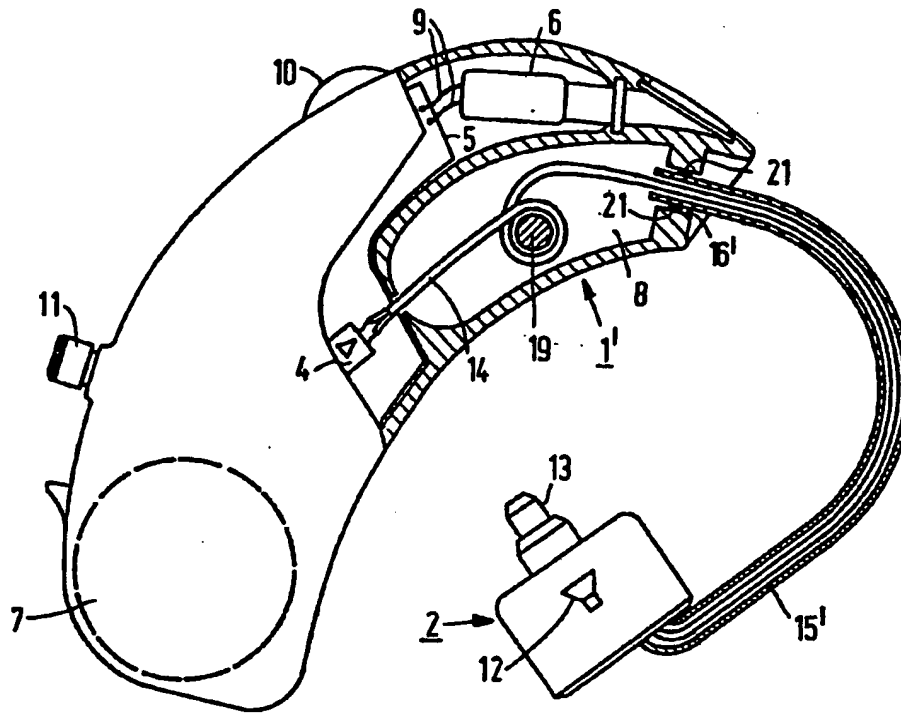


FIG. 6

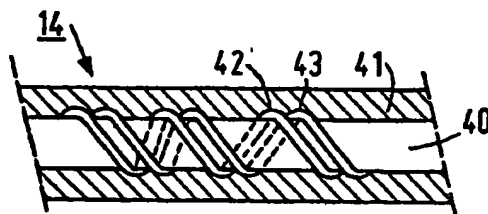


FIG. 7



European Patent  
Office

## EUROPEAN SEARCH REPORT

0158391

Application number

EP 85 20 0427

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
A	US-A-3 098 127 (W.H.HUTH) * Column 1, line 70 - column 4, line 23; figures *	1-3, 7-9, 11	H 04 R 25/02
A	DE-B-1 119 338 (MICROTECHNIC HÜBER & CO.) * Column 1, line 15 - column 2, line 48; figures *	1-3, 7, 9, 11	
A	US-A-4 381 830 (C.J.JELONEK) * Column 2, line 43 - column 3, line 46; figures *	1-3, 7, 9	
A	US-A-3 368 644 (J.D.HENDERSON) * Column 2, line 15 - column 3, line 18; figures 2-4 *	1	
A	US-A-3 031 537 (J.F.ROSE) * Figure 7; column 2, lines 15-53 *	1, 8	
			TECHNICAL FIELDS SEARCHED (Int. Cl.4)
			H 04 R G 02 C
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 18-06-1985	Examiner MINNOYE G.W.
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